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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Goddard Space Flight Center

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THE ECONOMIC CLUB OF DETROIT

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Speech by

Dr. James Fletcher

at

Detroit, Michigan

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NASA Headquarters
400 Maryland Avenue, N. W.
Washington, D. C.

(TRANSCRIPT OF A TAPE RECORDING.)

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P R O C E E D I N G S

(START OF TAPE ONE, SIDE ONE.)

MR. (SISLER): . . . to present Dr. Fletcher.

(Applause.)

DR. FLETCHER: Thank you Mr. (Sisler). Congressman (Griffiths), ladies and gentlemen.

It is indeed a privilege, I would say, to be invited to visit with you today, this first meeting of the year of the Economic Club of Detroit.

As you probably know on October 1 of this year, NASA will be fifteen years old and we'll be celebrating our fifteenth birthday in a number of ways, and I must say that during these fifteen years it's almost unbelievable to me what has happened in the realm of space endeavors both here and abroad. For fifteen years we have served under four presidents and we have had the responsibility of moving this nation into the real space age, and we have, I think, established American leadership in this field as well as aeronautical research.

During these fifteen years, as Mr. (Sisler) has mentioned, we have -- all four administrators of NASA prior to myself have been invited to address this very distinquished group. And also ~~at~~ as has been mentioned the Apollo 15 and Apollo 17 astronauts, Werner Van Braun, and others, have talked to you.

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I must assume from this that there is a very great interest in the space program by your organization. I hope this interest stems not only from the general awareness that technology is being moved ahead, and also not only from the fact that most of your companies are active participants in the space program. But I would like to think also that it is because the space program and the aeronautics program have an important role to shaping the economic future of the United States, and I will have something to say about that as I go along.

When Tom (Paine) was here -- my predecessor in 1970 -- the new space program for this decade was still being worked out. Now we have, I think, carefully defined a program and had it approved by the President and a very strong bipartisan majority in the Congress.

There has been a tendency to call this ~~program~~ Period the post Apollo program, and I would like very much to get away from this term. It really is the beginning of a new era, not the end of an old one. We are aiming at new levels of ~~confidence~~ Competency, performance, and new levels of technology which are quite different from the Apollo program and the other projects of the 1960's.

Of course, you never sharply make a break from one decade to another, there is always a continuity of change. But in -- keeping this in mind, I can say that the

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decade of the '60s will be different from the decade of the '70s in a number of ways.

First, in our planetary programs we are going to new regions of the solar system, far out to the giant planet Jupiter. And in the opposite direction to the very tiny planet Mercury and close to the sun itself. And, we'll make our first attempt to land instruments and cameras on the planet Mars. Or, in other words, unmanned voyages to the planets should be much more exciting and more productive in this decade than they were in the ~~'70s~~ 60s -- ~~the '60s~~.

We have left the moon and will probably not return in this decade, we the U. S. that is. Instead, we are building our first space base closer to home in what we call "near earth orbit", the so-called Sky Lab. ~~I mean~~ the production -- productive systems of an application satellite, the scientific observatories, the space shuttle to serve them, and supporting ground stations and data distribution centers are all part of the program to bring space back closer to earth.

Additionally, in place of the Apollo as our lead program to create new capabilities to operate in space, we have what we call the space shuttle. We have identified the shuttle as the one essential step we must take in this decade to assure ourselves of our future in space.

Fourth, we are coming to realize more and more

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that the most important space programs of NASA deal not only with outer space, but with the environment of earth and the quality of life here on our home planet. Even our exploration of the other planets we think ~~would~~ will lead to a better understanding of our own environment and how to protect it.

We will have new scientific observatories in earth orbit, but we will stress application satellites and the practical uses of space and space technology. In this decade we are emphasizing methodical preparation for intensified use of nearer earth space, not only in this decade, but in the '80s and in the '90s as well. This is obvious from our work in the space shuttle since it is a routine method of getting back and forth to near earth orbit, but perhaps it is less obvious, but equally important, that we are working to improve the satellites which will be launched and serviced by the shuttle.

Seven, most of our application satellites in the '60s were experimental. Now we are working to mature the technology for such satellites and are aiming at the establishment of operational systems. These will be owned primarily by other agencies of the U. S. Government, by international agencies, and by private enterprise.

We have a good example of this evolutionary process in the way communications satellites have moved swiftly from experimental to operational, and from government sponsorship

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to commercial ownership, and I will have more to say about that in a minute.

Eight, in this decade there is less emphasis on international competition as a spur to our space effort, but growing emphasis on international cooperation in space. International competition, when it does occur, will be economic in nature, not political and military as it was in the previous decade.

Nine, in this decade we are much better prepared and, therefore, more interested in finding ways that space technology can be used throughout the economy. We are a problem-solving agency, and ~~in~~ our methods and our experience are applicable to problems, I believe, in other fields as well. We do not think it very realistic to sit back and wait for technology spin-off to occur. We believe it to be much more productive to identify the problem areas where NASA know-how can be applied, and then to act positively to make the necessary technology transfer. But, we can only do this at the invitation of other government agencies -- state, local or federal -- who have the responsibility for the problem involved, or, of course, in cooperative arrangements with private industry.

Finally, as you might expect, there is a difference in budgets. In the peak years of the Apollo program, NASA's expenditures ran between five and six billion dollars per year. Our activities for this decade are now at a level of approximately half of this, including about $300 million for aeronautic research.

We believe that within the confines of this limited budget we can still maintain a strong balanced and productive space program. We have accepted the challenge of doing more for less and we will be well prepared to move more rapidly into any important area of space activity if the need to do so arises.

Now, these are the general characteristics of the new NASA program for the seventies. Let's look at what we are actually doing. Let's look at the missions themselves.

Although we are concentrating on activities in earth orbit in this decade, we will not neglect the planets. We have two pioneer satellites now on the way to the giant planet Jupiter. Pioneer 10 is planned to arrive in December of this year, and Pioneer 11 approximately one year later.

In 1977 we will launch two larger and more complex, what we call Mariner-typed space craft to fly by Jupiter and then on to the very interesting planet, Saturn. In November of this year we will launch a Mariner space craft on an unprecedented mission toward the sun, flying first by Venus and then using the gravity attraction of Venus to fly us on, ~~as~~ we call it whiplash us on, so that we

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can arrive ~~to~~ at the planet Mercury, as close to six hundred miles to Mercury if all goes well. If everying goes according to schedule, the Mariner will pass Mercury during April of next year. It will be the first such space craft to use the gravity of one planet to speed on to another, and also we will get a good look at the planet Mercury, which so far we've only been able to see from earth-based telescopes.

Surface details of the planet Mars are now reasonably well-known, thanks to the spectacular photographs in 1972 of Mariner 9. Mariner 9 was the first space craft from earth to go into orbit around another planet, if we don't count the moon as a planet. When it arrived, as you remember, in 1971 a giant dust storm was raging, we have nothing like that on earth and for a while people were concerned that we would not be able to observe the surface. But, the space craft lasted a good bit longer than it was designed to do and after the dust storm relinquished or abated ~~evaded~~, we were able to photograph essentially all of the surface of Mars and we have a pretty good idea of what it's like. It is much more interesting than first we had thought. There are craters like the moon, but there are also deep rifts, valleys, water, ice, many of the things we have on earth, but it does look like a relatively dead planet in comparison with our beautiful, blue earth.

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Nevertheless, there is a possibility that some life will be observed and so ~~in~~ on July 4, 1976, or approximately then, we will land our first spacecraft on the planet Mars, and hopefully -- we are launching two -- hopefully both of them will land, one in the polar region and one down closer to the equatorial region.

Of course, the Soviets are a little bit ahead in ~~the~~ their exploration of the planet Mars. They have four spacecrafts at the present time on their way to Mars, two of them expected to land. Whether the instrumentation will be sufficient to give us a better picture of what Mars is really like, of course, remains to be seen later on this year.

I would like to come back to the Pioneer Ten flight to Jupiter, for a few moments, because this is a mission of great potential interest, and because, in a way, it is a transportation story of the first magnitude.

Pioneer Ten was launched on March 3, 1972, and left the earth at about 32 thousand miles per hour, the fastest man made object that we have ever flown, or that anyone has ever flown. If the Apollo astronauts could have travelled that fast they could have reached the moon in eleven hours instead of three and a half days.

Pioneer Ten has been underway for eighteen and a half months and ~~have~~ has covered nearly a half a billion miles.

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If Pioneer Ten is not destroyed by radiation from Jupiter, or trapped by Jupiter's intense gravity field, it will continue on outward from the sun and about fourteen years from now it will cross the orbit of Pluto and leave the solar system forever and wander through the star systems of the Milky Way galaxy.

We have a plaque on board Pioneer Ten which is its calling card if you like and if it's ever intercepted by intelligent beings, they will know whence it came and for what it was designed.

Pioneer Ten is also a remarkable communications story. It is not a big spacecraft to begin with, it weighed only 568 pounds when it was launched, so the allowance for communication equipment and power sources and antennae and so forth ~~were~~ WAS quite limited.

Pioneer Ten carries radio isotope, thermo-electric generators as its primary source of electric power. We can't use solar power that far away from the sun. So necessity becomes a mother again and produces the radio isotope, thermo-electric generator, much the same as the kind WE used in Apollo when we left the scientific instruments on the moon.

Pioneer radio signals will start from the vicinity of Jupiter with the strength of about eight watts, just eight watts not kilowatts, travelling at the speed of light

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they will take 45 minutes to reach the tracking stations of NASA's deep space network, and by the time these signals reach the earth they will be decreased in strength to only a tiny fraction of a watt. But we are prepared for that.

On our large (parabolic) antennae s, 210 feet in diameter, we can pick up signals from Pioneer as weak as one quintillion of a watt -- we don't use that word in engineering terminology -- that means 10 to the minus 18th watts for the engineers in the crowd. If you could collect that amount of energy for 19 million years, it would light a small christmas tree bulb just barely.

Still, NASA's deep space network stations in Australia and Spain and in Goldstone, California, expect to pick up these weak SIGNALS ~~stations~~ and convert them into useful data including some color images of the planet Jupiter.

These figures seem impressive to me but I cite them FOR YOU to make another point. They illustrate how way-out assignments like exploring the planets do FORCE ~~for~~ technological progress and help fill the nation's reservoir of new technology. I don't need to add that no one in the world, either side of the Iron Curtain, has antennae s with this kind of capability.

If tiny Pioneer Ten is able to send back useful, new information about Jupiter, or any of its twelve lr

satellites, it will be one of the great scientific and engineering achievements of this century. It is only the beginning of a long quest for knowledge that will eventually lead men to land on one of the moons of Jupiter some time during the 21st Century.

Now we mentioned the moons of Jupiter only because they are likely candidates for a source of life in our solar system. There isn't time to go into why that is the case, but certainly they are more likely than the planet Mars, but I am afraid we will have to wait for the 21st century -- I hope we are all around then.

Meanwhile, back in earth orbit we have important work to do in this decade. Even as we prepare to explore the famous rings of Saturn, we are establishing useful spacecraft rings about the earth. We have moved forward very rapidly with three classes of satellites in earth orbit: communication satellites, earth observation satellites, and scientific satellites which look out into the universe.

I think the communication satellite story makes a very good illustration of the cooperation between industry and government. The first synchronous satellite was launched in synchronous orbit ten years ago and weighed about 80 pounds. Today, communication satellites launched by the ComSat Corporation weigh more than a thousand pounds.

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There are five such satellites and each of them carries -- or together they carry more telephone conversations than all of the telephone cables put together.

In this particular case industry played the major role in the success of the project. The Hughes Aircraft Company took the initiative in urging the use of synchronous orbit for communication satellites and made a substantial investment of its own funds to prove that synchom was feasible before NASA took over the responsibility for it.

So you see -- and by the way, they also ended up with most of the business from Comsat Corporation, so the investment was a good one. At the present time the five satellites of Comsat, the five large ones, handle up to nine thousand telephone conversations at one time, or twelve T.V. satellites.

We are phasing out of the communications satellite business at NASA and a lot of people have asked us, "Why just when things are going good you phase out?" It is because simply American industry is well equipped to take over from NASA. At the present time there are seven U. S. domestic companies planning to launch sixteen satellites over the next two years. These are communications satellites which at the present time we feel can best be handled by private enterprise.

The use of earth observation satellites is also

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expanding rapidly. NASA has worked with the Department of Commerce since the beginning of the space age to develop weather satellites, but at the present time we are flying a surprisingly new kind of observation spacecraft called the earth resources technology satellite, ERTS 1.

We call it surprising because we have known for years that cloud pictures from space would be valuable, but we did not realize until fairly recently what a wealth of new information could be gathered about the earth and what man is doing ~~through~~ TO it and with it from an ~~Earth's~~ ERTS type satellite flying at an altitude of 570 miles.

Thousands of scientists and public officials and industry representatives, not only in this country but around the world, are busy today scanning the images that ERTS produces. Hundreds of valuable uses for this type of information have already been identified and more are being discovered all the time.

If I had to pick out one spacecraft, one space age development which NASA is producing which would help save the world, I would pick ERTS and the operational satellites that go with it which I believe will go a long ways towards helping man to save his home -- this planet Earth.

I ought to say something about the Sky Lab Program because that is our main manned space program that is underway at the present time and as Mr. (Sisler) has already
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indicated, that we expect the SL III crew, the second crew to return a week from tomorrow -- everything is on schedule, their health is better than the first crew even though they would have been up there for fifty-nine days, the scientific and the applications experiments aboard the Sky Lab have already exceeded our expectations that we had even before the trouble began. We are way ahead of schedule on all of the things and just now scientists and technologists throughout the country and the world are beginning to analyze the data.

~~Sky Lab III is scheduled to be launched~~, Sky Lab IV is scheduled to be launched on ~~October the 4th~~ November the 11th ~~rather~~ WW and with some luck we ought to be able to take solar-type observations, telescopes with U.V., and X-ray, and gamma ray, take these kinds of images of the comet (Cohutect). Now most of you haven't heard much about (Cohutect) but you will be in December because that will be the brightest thing in the sky outside of the moon. While this is going on we hope the Sky Lab will be able to take some very good scientific readings on that particular object.

To summarize this report on the new NASA space program for the '70s, let me say the following.

We are making good progress in all important areas. So far as funding goes, we are lean but healthy.

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Some people say that we are undernourished, but not starved. We are doing more in this decade for less because we could build on the capabilities created in the '60s. We are now at work on plans for the new programs we will need to start later in this decade.

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The next NASA Administrator to come to (G~~oddall~~) will give you the results of this effort which will, in time, become the new NASA program of the '80s. And, we have developed an enormous bank of new technology which is gradually being put to use in the general economy as well as into the next generation of space missions.

This new technology has moved into almost every industry and is being used in every segment of our society. This includes, of course, the automotive industry~~, and I'd like to give you some examples because I understand the automotive industry is rather popular and very common here in the Detroit~~ area.

Now, these are not meant to be solutions, but only examples of ways that we do interweave with the automotive industry. For example, the NASA developed computer program is being used for designing critical parts of light trucks and cars. We call this at NASA (Nastran). It predicts the performance of critical load structure such as steering linkages. The company using Nastran reports a 60 percent improvement in predicting the behavior of components under

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stress and a time saving of two-thirds in achieving calculations. It plans to use Nastran in an increasingly wide range of functions.

Another example, some years ago the astronauts had trouble with their space helmet visors fogging up and as a result we developed an anti-fogging compound for the specialized conditions of space flight. It could also be used on car windshields and motorcycle helmet visors.

An ultrasensitive, fast scanning infrared optical device developed by NASA is now seeing daily industrial use FOR testing the safety of automobile and aircraft tires. The device is the first, I am informed, that permits the nondestructive testing of tires -- I'm not sure that's true, some people have told me that.

Just recently I signed off on a patent which consists of a new composite material which can be self-lubricating at very high temperatures and it is to be marketed soon under licensing agreement with NASA. The composites florides impregnated into porous nickle cobalt or iron ~~allies~~ ALLOYS show excellent wear-resistant qualities under tests. A typical application -- maybe I shouldn't say this -- typical application might be in rotary engines of the (wikle) type which have a high temperature lubrication requirement, and so on. The list is long; but these are examples of the kinds of things that we call spin-offs

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in the space program.

I think one other example probably is worth calling your attention to. It's a -- it's a spin-off, in a sense, but it's part of our effort to make NASA technology available to industry as a whole.

NASA's is taking a hard look at the whole range of opportunities suggested by the use of hydrogen as a fuel. There's a recent article in Fortune Magazine, in -- last November, which gives you some idea of what these possibilities are.

But I would take one example only. There's a fair amount of interest at the present time in an experimental hydrogen injection program for automobile engines.

This work is going on in -- at the Jet Propulsion Lab of the California Institute of Technology, under a NASA contract.

The NASA JPL Program is an exciting, experimental effort to bring old and new technology to bear on one of the major problems of modern society.

Work on the program is -- consists of two phases -- Phase I began last April and will become completed this December.

The idea is simply to inject hydrogen into a standard automobile engine which is operated on a lean mixture ratio, and it ~~usually~~ turns out if you do this, the automobile

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engine functions rather well, at least as efficient, probably more efficient than the standard engine and, of course, with no pollution if operated on the lean side.

I don't want to say this is a cure-all, but it does work. We have an engine that's working now at the Jet Propulsion Lab. We expect to have a car running on hydrogen injection this November.

And right now, this week, and next week, we have representatives from all of the major automobile industries out there looking at the program.

Of course, we don't plan to carry hydrogen aboard automobiles, except in a demonstration test. The trick is to develop a hydrogen generator which works off gasoline.

We have active work on a hydrogen generator. We are not the ones to produce it Cheaply ~~chiefly, and~~ -- and easily, with low WEIGHT ~~waste~~, but nevertheless we are working closely with some representatives of the automobile industry to see whether that can be an economical way of getting low pollution, high efficiency, automobile ~~industry automobile~~ engineS.

We first became interested in this, of course, through airplane engines and we do this routinely, in experimental airplane ENGINES SINCE ~~industries because~~ we have a pollution problem there, as well.

We expect someday, maybe, airplanes will be run on hydrogen fuel -- liquid hydrogen probably, in this case. We

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began the work on automobile engines primarily because of the encouragement we received from the EPA -- ~~maybe that's not a good thing to mention here, but~~ We work very closely with EPA on all of these programs.

Now, we've made a special effort at NASA to meet informally with groups of corporation executives from non-aero space industries all around the country.

The purpose of these meetings is to brief the industry people at the top executive level about advanced technology that ought to be of use.

And beyond that, we want to listen to industry leaders and get their ideas on how NASA can help. I'm convinced that our technology transfer messages are getting through at the engineering level to almost everyone in industry.

But they also need to be FLOWING TO the Board Rooms, as well. I plan to participate in the program personally, to the extent that my schedule permits.

I had a very valuable exchange about two weeks ago down at Houston, at the dedication of the Lyndon B. Johnson Space Center.

And I plan to be in Los Angeles for A similar discussion in early October, and I'm planning to schedule others throughout the country.

I would like to suggest that you might go ~~and~~ OR send some of your brightest engineers to visit the ~~National~~ NASA Research

Centers. The ~~Louis~~ LEWIS Research Center, for example, is having open-house -- ~~we call it an open-house or an inspection --~~ Wednesday, Thursday, and Friday of this week.

Beyond that, it is always open-house at NASA, when knowledgeable people from industry want to talk about advanced technology transfer.

Come and see us. If you don't, we'll come and see you anyway.

Thank you very much.

: Dr. Fletcher, thank you very much. And -- Mr. (~~$~~Cisler) is on a tight schedule today and he has to run a preferred stockholder's meeting of Detroit Edison, so -- for the first time -- I'm going to take over the questions and this will be fun, I think.

Does the NASA program show promise of new source of energy -- practical source for heating homes or driving machinery?

DR. FLETCHER: No, I think NASA does not show promise of a new source of energy. Hydrogen, itself, is not a source of energy.

It's only a way of -- -- transmitting energy from one form to another, which -- in some cases -- it may be more desirable.

If we produce hydrogen, it will be produced from electrical energy -- electrolysis -- or by probably coal energy. You can produce hydrogen about as cheap as ~~natural gas~~ -- synthetic gas -- from coal.

So it's not really a new source of energy. It's a new form of energy from the original.

: Thank you.

DR. FLETCHER: The Skylab astronauts are working in an A-minus O-Q atmosphere --

: -- and what are the techincal difficulties developing in the way of artificial gravity environment with space travel?

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DR. FLETCHER: I don't like to correct Mr. (~~Sweeney~~) here, he says ~~[illegible]~~ -- it means -- ~~[illegible]~~ G.

: Oh! Good!

DR. FLETCHER: Zero G ~~0-Z~~ environment. There are problems with Zero G ~~0-Z~~. And the astronauts are learning to cope with it. We find that most of the problems, however, are health problems.

And judging by what we have done with the second group of astronauts, they seem to be more -- much more healthy at the present time -- at the end of almost eight weeks than the previous astronauts were at the end of 4 ~~[illegible]~~ weeks.

Time will tell. When we get them back on the ground. They may be a little shaky in terms of walking, because they haven't used their walking muscles. But aside from that, we

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find no difficulty at all working at Zero G and we don't plan to have artificial gravity aboard future missions.

: We understand the Skylab One Crew took some dramatic photos of the sun. Have we learned anything new from these photographs?

DR. FLETCHER: The answer is unequivocably, yes. It would take a long time to describe to you the new things that are coming out of these -- it's not just photographs -- but we look at the sun with every instrument imaginable.

And the whole idea of the sun is a completely different one at the present time than we had before Skylab.

Unfortunately, the data aren't all put together, so the new concept of the sun really isn't firm yet. All we can say, is the sun is a very dynamic body.

It's a little frightening, somehow because we depend on almost every -- everything we do -- on the energy from the sun.

And we had thought if there's anything steady and stationary it was the sun. Unfortunately, that does not seem to be the case.

It's a very mobile, moving dynamic boiling, bubbling, star and it does have an impact. Hopefully, on the average, the heat that comes through our atmosphere will be relatively constant so that we don't either have another ice age or that we don't have a burning up of our population.

So far, we've done pretty well by the sun. It's a little scary perhaps to know too much about it, but we are beginning to focus in on what actually makes the sun work,

And what are the variations in it.

: The ~~earliest~~ ERTS photographs which we have seen have been spectacular. Skylab gives you another opportunity to conduct earth research surveys. Can you comment on the ~~[illegible]~~ ERTS program including results from Skylab?

DR. FLETCHER: Well, yes. I'm sure, as I said, the ERTS ~~[illegible]~~ program itself is probably the most important thing in the long run to come out of the space program.

Because it does, on a routine basis, allow us to observe every place on the globe precisely in different color bands, particularly the infrared, precision imagery about every point on the globe every 18 days.

And so we can observe changes in what's happening to our globe. The slow changes caused by development programs but also the rapid changes, such as forest fires, diseases of forests ~~[illegible]~~ diseases of crops, pollution, oil spills, and so on.

And, in the long run, that's going to be the way we keep track of what is happening on our planet.

: Is the joint space venture with Russia on schedule? Are there any problems being encountered?

DR. FLETCHER: The answer to the question is yes, the program is on schedule. Of course, it's in the design phase on

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each other's side. Not in a testing phase. So it is a little early to say.

We have a delegation going over -- I've asked Deputy Administrator, George ~~Lowe~~ Low, to go with them in October. To be sure there are no loose ends in the program.

So far it looks like there are none, even their ~~communi -- the~~ public relations program seems to be working out.

We were afraid that they would have to keep their part very secretive, where ours is open, but that does not seem to be the case, I think we're going to have a good public relations program.

By that, I mean, communications with the public, on both sides.

: What is ahead in NASA for general aviation?

DR. FLETCHER: Well, that's quite a broad subject, too. But we are -- just in the past year -- setting up a program office for dealing with general aviation.

The kind of things that we're working on are advanced, low pollution aircraft engines, not the hydrogen engines, but a simpler design, where we -- we're working also on low cost turbine engines.

General aviation primarily is in the propeller type aircraft and we think the turbines and, finally, the jets, need

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to be reduced in cost in order to -- for the general public to make use of them.

The airport problem is a very big one and we are working with the Department of Transportation -- it's a joint program -- to help find new ways of dealing with general aviation so that it does not, impact unduly on the military and the commercial aspects.

: And the final question, we understand Skylab Three Crew will go up on November 9th. What is their target for days in space?

DR. FLETCHER: The target for Skylab -- we call it Skylab Four because Skylab One was the laboratory itself. Skylab Two was the first crew, Skylab Three was the second crew and this will be Skylab Four, which is the third crew.

The target is 56 days, the same as the Skylab Three Crew, but we can't be precise about that. Because we don't try to control the precise location of the Skylab in orbit.

And as it goes around, I've forgotten how many revolutions it has, but it's in the thousands, it deviates slightly from our calculations, due to anom~~i~~alies ~~aereus~~ in the earth's gravitational ~~feel~~ Field.

And so, when we say 56 days, we mean approximately 56 days. But we like to have the astronauts come down at a very precise location, approximately 300 miles off of San Diego.

And so, what started out to be 56 days on the Skylab

Three Crew, is going to be 59 days. Three days longer. All I can say is that the duration for Skylab Four is designed to be 56 days.

It may be a little short, or it may be a little long. There is another factor that might influence that and that is if KAHOUTEK (Kahoutec) the Comet (~~Kahoutec~~) turns out to be very interesting, and we're getting good data, we might just prolong that mission.

So ~~[illegible]~~ the answer to that is approximately 56 days.

(Applause)

: Dr. Fletcher, we thank you for taking time out of your busy schedule to come to Detroit and give us such a learned discussion on this subject. Thank you very much and this meeting is adjourned.

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C E R T I F I C A T E

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"A Look At The New NASA Program"

Guest of Honor and Speaker

JAMES C. FLETCHER, Ph.D.

Washington, D.C.

Administrator

National Aeronautics and Space Administration

BEFORE THE ECONOMIC CLUB OF DETROIT

September 17, 1973

Cobo Hall

Presiding Officer

WALKER L. CISLER

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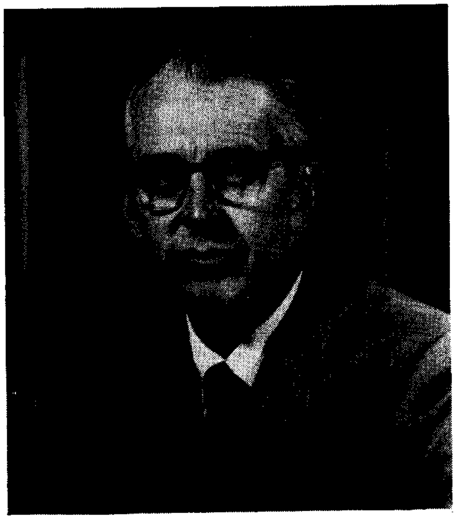

DR. JAMES C. FLETCHER

Dr. James C. Fletcher was sworn in as Administrator of the National Aeronautics and Space Administration on April 27, 1971. President Nixon announced Dr. Fletcher's nomination as NASA Administrator on February 27, 1971 and the appointment was confirmed by the U.S. Senate on March 11, 1971.

James Chipman Fletcher was born June 5, 1919 in Millburn, New Jersey, attended high school in Flushing, New York and graduated from Bayside High School, Bayside, New York. He received a B.A. degree in physics with a minor in mathematics from Columbia University in 1940.

After graduation, Dr. Fletcher served as a research physicist with the U.S. Navy Bureau of Ordnance, at Port Townsend, Washington, studying the problems of degaussing ships as protection against magnetic mines.

In 1941 he became a special research associate at the Cruft Laboratory of Harvard University. He went to Princeton University in 1942 as a teaching fellow and later was an instructor and research physicist.

At the end of World War II, he began work on a doctorate in physics at the California Institute of Technology under a teaching assistantship and an Eastman Kodak Fellowship. After receiving his Ph.D. degree in 1948, Dr. Fletcher joined Hughes Aircraft Co., Culver City, California, as director of the Theory and Analysis Laboratory in the Electronics Division. Six years later this division—instrumental in developing the Falcon air-to-air missile and the F-102 all-weather interceptor—had grown from 120 to 25,600 employees.

In 1954, Dr. Fletcher joined the Ramo-Wooldridge Corp. as an Associate Director and soon became Director of Electronics in the Guided Missile Research Division. Later the Guided Missile Division became Space Technology Laboratories, a subsidiary of Ramo-Wooldridge, with technical responsibility for all United States intercontinental ballistic missiles (Atlas, Titan and Minuteman), as well as the Thor intermediate range ballistic missile. The laboratories also initiated Pioneer 4, the nation's first space probe.

In July 1958, Dr. Fletcher organized and was first president of the Space Electronics Corp., at Glendale, California, with his associate, Frank W. Lehan.

Space Electronics Corp. developed and produced the Able Star stage of the Thor-Able space carrier and had grown to 300 employees by 1960 when controlling interest was sold to Aerojet General Corp.

A year later, Space Electronics Corp. was merged with the spacecraft division of Aerojet to form the Space General Corp. Dr. Fletcher was responsible for the formation of this new corporation and was its first president. He later became Chairman of the Board of Space General and Systems Vice President of Aerojet General Corp. He served in this dual capacity until July 1, 1964 when he resigned to become the eighth president of the University of Utah.

In his career as a research scientist, Dr. Fletcher developed patents in areas as diverse as sonar devices and missile guidance systems. He continues his interest in science through national committee work, having served on more than 50 national committees and as chairman of 10.

In March 1967, Dr. Fletcher, after serving as a consultant since its inception in 1958, was appointed by President Johnson to membership on the President's Science Advisory Committee.

He was a member of the President's Committee on the National Medal of Science; and of several Presidential Task Forces, the most recent being the Task Force on Higher Education.

He is a Fellow of the Institute of Electrical and Electronics Engineers, an Associate Fellow of the American Institute of Aeronautics and Astronautics and a member of the Board of Trustees of the Theodore von Karman Memorial Foundation. He received the first Distinguished Alumni Award to be given by California Institute of Technology. He received an Honorary Doctor of Science Degree from the University of Utah in June 1971.

Dr. Fletcher is married to the former Fay Lee of Brigham City, Utah, and has four children.

(The meeting was opened by President Russel A. Swaney, who presented Walker L. Cisler, Chairman of the Board, The Economic Club of Detroit, and Chairman of the Board, The Detroit Edison Company, as Presiding Officer.)

WALKER L. CISLER: President Swaney, distinguished guests, members of The Economic Club of Detroit, ladies and gentlemen:

I am happy to serve as the Presiding Officer at the first meeting of the 40th Season of The Economic Club of Detroit and to have the honor of presenting to you our distinguished guest, Dr. James C. Fletcher, Administrator of the National Aeronautics and Space Administration.

I am sure you have read in the program for our meeting about Dr. Fletcher's remarkable career as a research physicist in government and in industry, as a director of aerospace research and development, as an inventor of great originality in electronic technology, as the founder of a successful business organization, as officer and chairman of a large corporation, as consultant to the Executive Branch of the Federal Government, and as president of an outstanding university.

His career demonstrates the dynamic character of American technical enterprise in the twentieth century, and it augurs well for the future of our nation.

It was fitting that such a man be chosen to lead NASA, certainly the most dramatic and courageous example of the human spirit—the exploration of space by machines and instruments, and so remarkably well by men themselves.

As we meet here, Skylab Two continues to orbit the earth safely—I might almost say routinely—with a splashdown already precisely calculated as to timing and point of landing just eight days from now. These are achievements that are almost beyond comprehension in their complexity and technological sophistication.

It was my privilege to have a small part in the beginnings of our space program in 1959 when Keith Glennan was Administrator of NASA and when Neil McElroy was Secretary of Defense. The Secretary asked me to accept a special assignment for the Department of Defense which was essentially to assure that the space program could be managed successfully, despite its great complexity, and that when Americans were sent into space they would be able to get back safely.

I was given a most thorough briefing of what we then had as to programs, ranges, tracking stations and data reduction centers. I visited the facilities personally and in due course made my recommendations and my assurance that a project of this extraordinary scope could be managed effectively.

And so I have followed closely and with enthusiasm the accomplishments that ensued during the 1960s and to the present day. The work of NASA has served us well overseas because the success has brought great recognition to our nation.

It has been the most highly organized scientific and physical undertaking in history. It required a great organization, such as NASA, supported by government and private industry, to carry it out successfully.

It is my fervent hope that our nation will support NASA in the future because there is so much to be done and so much to be learned from space exploration, not the least of which is to view our own planet, its resources and life forms with the appreciation that comes from a fresh perspective.

And, finally, the space program requires such specially gifted men as our guest of honor.

I am delighted to present to you Dr. James C. Fletcher, Administrator of the National Aeronautics and Space Administration, who will now address himself to the subject he has chosen for us: "A LOOK AT THE NEW NASA PROGRAM." Dr. Fletcher.

(Applause)

DR. JAMES C. FLETCHER: It is indeed a privilege to be invited to visit with you today, this first meeting of the fall season of the Economic Club of Detroit.

As you probably know, on October 1 of this year NASA will be 15 years old. We will be celebrating our 15th birthday in a number of ways, and I must say that it is almost unbelievable to me what has happened during these 15 years in the realm of space endeavors both here and abroad. For 15 years NASA has served under four presidents and we have had the responsibility of moving this nation into the real space age, and we have, I think, established American leadership in this field as well as in aeronautical research.

During these 15 years all four administrators of NASA have been invited to address this very distinguished group. The Apollo 15 and Apollo 17 astronauts, Wernher von Braun, and others, have also talked to you.

I must assume from this that there is a very great interest in the space program by your organization. I hope this interest stems not only from the general awareness that technology is being moved ahead, and not only from the fact that most of your companies are active participants in the space program, but also from the belief that the space program and the aeronautics program have an important role in shaping the economic future of the United States, and I will have something to say about that as I go along.

When Tom Paine, my predecessor at NASA, was here in 1970, the new space program for this decade was still being worked out. Now we have, I think, carefully defined a program and had it approved by the President and a very strong bipartisan majority in the Congress.

There has been a tendency to call this the "post-Apollo program," and I would like very much to get away from this term. We really are at the beginning of a new era, not the end of an old one. We are aiming at new levels of competence and performance and new levels of technology which are quite different from the Apollo program and the other projects of the 1960's.

Of course, you never sharply make a break from one decade to another, there is always a continuity of change. But keeping this in mind, I can say that the decade of the Seventies will be different from the decade of the Sixties in a number of ways.

One. In our planetary programs we are going to new regions of the solar system, far out to the giant planet Jupiter. And in the opposite direction to the very tiny planet Mercury and close to the Sun itself. And we will make our first attempt to land instruments and cameras on the planet Mars. In other words, unmanned voyages to the planets should be much more exciting and more productive in this decade than they were in the Sixties.

Two. We have left the Moon and will probably not return in this decade, "we" meaning the United States. Instead, we are building our first space base closer to home in what we call "near Earth orbit." The productive systems of application satellites, the scientific observatories, the Space Shuttle to serve them, and supporting ground stations and data distribution centers are all part of the program to bring space back closer to Earth.

Three. In place of Apollo as our lead program to create new capabilities to operate in space, we have the Space Shuttle. We have identified the Shuttle as the one essential step we must take in this decade to assure ourselves of our future in space.

Four. We are coming to realize more and more that the most important space programs of NASA deal not only with outer space, but with the environment of Earth and the quality of life here on our home planet. Even our exploration of the other planets will lead, we think, to a better understanding of our own environment and how to protect it.

Five. We will have new scientific observatories in Earth orbit, but we will stress application satellites and the practical uses of space and space technology.

Six. In this decade we are emphasizing methodical preparation for intensified use of Near Earth Space, not only in this decade, but in the Eighties and in the Nineties as well. This is obvious from our work on the Space Shuttle since it is a routine method of getting back and forth to Near Earth Orbit, but perhaps it is less obvious, but equally important, that we are working to improve the satellites which will be launched and serviced by the Shuttle.

Seven. Most of our application satellites in the Sixties were experimental. Now we are working to mature the technology for such satellites and are aiming at the establishment of operational systems. These will be owned primarily by other agencies of the U.S. Government, by international agencies, and by private enterprise.

We have a good example of this evolutionary process in the way communications satellites have moved swiftly from experimental to operational, and from government sponsorship to commercial ownership, and I will have more to say about that in a minute.

Eight. In this decade there is less emphasis on international competition as a spur to our space effort, but growing emphasis on international cooperation in space.

Nine. In this decade we are much better prepared for—and, therefore, more interested in—finding ways that space technology can be used throughout the economy. We are a problem-solving agency and our methods and our experience in space and aeronautics are applicable to problems, I believe, in other fields as well. We do not think it very realistic to sit back and wait for technology spin-off to occur; we believe it to be much more productive to identify the problem areas where NASA know-how can be applied, and then to act positively to make the necessary technology transfer. But we can do this only at the invitation of other government agencies—state, local or federal—who have the responsibility for the problems involved, or, of course, in cooperative arrangements with private industry.

Finally, as you might expect, there is a difference in budgets. In the peak years of the Apollo program, NASA's expenditures ran between $5 and $6 billion per year. Our activities for this decade are now at a level of approximately half of this, including about $300 million for aeronautics research.

We believe that within the confines of this limited budget we can still maintain a strong, balanced, and productive space program. We have accepted the challenge of doing more for less. And we will be well prepared to move more rapidly into any important area of space activity if the need to do so arises.

Now these are the general characteristics of the new NASA program for the Seventies. Let's look at what we are actually doing, at the missions themselves.

Although we are concentrating on activities in Earth orbit in this decade, we will not neglect the planets. We have two Pioneer spacecraft now on the way to the giant planet Jupiter. Pioneer 10 is planned to arrive in December of this year, and Pioneer 11 approximately one year later.

In 1977 we will launch two larger and more complex Mariner-type spacecraft to fly by Jupiter and then on to the very interesting planet Saturn. In November of this year we will launch a Mariner spacecraft on an unprecedented mission toward the Sun, flying first by Venus and then using the gravity attraction of Venus to fly us on, or "whiplash" us on, so that we can pass close to the planet Mercury, as close as 600 miles if all goes well. According to our schedule, this Mariner will pass Mercury during April of next year. It will be the first spacecraft to use the gravity of one planet to speed on to another, and also the first to get a good look at the planet Mercury.

Surface details of the planet Mars are now reasonably well known, thanks to the spectacular photographs sent back in 1972 by Mariner 9. Mariner 9 was the first spacecraft from Earth to go into orbit around another planet, if we do not count the Moon as a planet. When it arrived at Mars in 1971 a giant dust storm was raging. We have nothing like that on Earth and for a while people were concerned that we would not be able to observe the Mars surface. But the spacecraft lasted a good bit longer than it was designed to do, and after the dust storm abated, we were able to photograph essentially all of the surface of Mars and we have a pretty good idea now of what it is like. It is much more interesting than first we had thought. There are craters like the Moon, but there are also deep rifts, valleys, water, ice, many of the things we have on Earth, but it does look like a relatively dead planet in comparison with our beautiful blue Earth.

Nevertheless, there is a possibility that some life exists on Mars, and so on July 4th, 1976, or approximately then, we will land the first of two Viking spacecraft on Mars. Two quite different landing sites have been chosen, one in the polar region and one closer to the equatorial region.

Of course, the Soviets are a little bit ahead in their exploration of the planet Mars. They have four spacecraft at the present time on their way to Mars, two of them expected to land. Whether the instrumentation they carry will be sufficient to give better pictures of what Mars is really like remains to be seen.

I would like to come back to the Pioneer 10 flight to Jupiter, for a few moments, because this is a mission of great potential interest, and because, in a way, it is a transportation story of the first magnitude.

Pioneer 10 was launched on March 3, 1972, and left the Earth at about 32 thousand miles per hour, the fastest man-made object that we have ever flown, or that anyone has ever flown. If the Apollo astronauts could have travelled that fast they could have reached the Moon in eleven hours instead of three and a half days.

Pioneer 10 has been underway for eighteen and a half months and has covered nearly a half a billion miles. If Pioneer 10 is not destroyed by radiation from Jupiter, or trapped by Jupiter's intense gravity field, it will continue on outward from the Sun and about 14 years from now it will cross the orbit of Pluto and leave the solar system forever and wander through the star systems of the Milky Way galaxy.

We have a plaque on board Pioneer 10 which is its calling card, if you like, and if it's ever intercepted by intelligent beings, they will know whence it came and for what it was designed.

Pioneer 10 is also a remarkable communications story. It is not a big spacecraft to begin with, it weighed only 568 pounds when it was launched, so the allowance for communication equipment and power sources and antennae and so forth was quite limited.

Pioneer 10 carries radio isotope thermo-electric generators as its primary source of electric power. We cannot use solar power that far away from the Sun. So necessity becomes a mother again and produces the radio isotope thermo-electric generator. Similar generators are also used to return data from the scientific instruments left on the Moon by the Apollo astronauts.

Pioneer radio signals will start from the vicinity of Jupiter with the strength of about eight watts, just eight watts, not kilowatts. Travelling at the speed of light, they will take 45 minutes to reach the tracking stations of NASA's deep space network, and by the time these signals reach the Earth they will be decreased in strength to only a tiny fraction of a watt. But we are prepared for that.

On our large parabolic antennae, 210 feet in diameter, we can pick up signals from Pioneer as weak as one quintillionth of a watt—we don't use that word in engineering terminology, that means 10 to the minus 18th watts for the engineers in the crowd. If you could collect that amount of energy for 19 million years, it would light a small Christmas tree bulb for only a fraction of a second.

Still, NASA's deep space network stations in Australia and Spain and in Goldstone, California, expect to pick up these weak signals and convert them into useful data, including some color images of the planet Jupiter.

These figures seem impressive to me but I cite them to make another point. They illustrate how way-out assignments like exploring the planets do force technological progress and help fill the nation's reservoir of new technology. No one else in the world, on either side of the Iron Curtain, has antennae with this kind of capability.

If tiny Pioneer 10 is able to send back useful, new information about Jupiter, or any of its twelve satellites, it will be one of the great scientific and engineering achievements of this century. It is only the beginning of a long quest for knowledge that will eventually lead men to land on one of the moons of Jupiter some time during the 21st Century.

I mention the moons of Jupiter only because they are likely candidates for a source of life in our solar system. There is not time to go into why that is the case, but certainly they are more likely to support life than the planet Mars, but I'm afraid we will have to wait for the 21st Century to find out whether they really do or not.

Meanwhile, back in Earth orbit we have important work to do in this decade. Even as we prepare to explore the famous rings of Saturn, we are establishing useful spacecraft rings about the Earth. We have moved forward very rapidly with three classes of satellites in Earth orbit: communication satellites, Earth observation satellites, and scientific satellites which look out into the universe.

I think the communication satellite story makes a very good illustration of the cooperation between industry and government. The first synchronous satellite was launched in synchronous orbit 10 years ago and weighed about 80 pounds. Today, communication satellites launched by the Comsat Corporation weigh more than a thousand pounds.

There are five such satellites and together they carry more telephone conversations than all of the undersea cables put together.

In this particular case industry played the major role in the success of the project. The Hughes Aircraft Division took the initiative in urging the use of synchronous orbit for communication satellites and made a substantial investment of its own funds to prove that "Syncom" satellites were feasible before NASA took over the responsibility for them.

And by the way, Hughes Aircraft also ended up with most of the business from Comsat Corporation, so the investment was a good one. At the present time the five satellites of Comsat, the five large ones, handle up to nine thousand telephone conversations at one time, or twelve television transmissions.

We are phasing out of the communications satellite business at NASA and a lot of people have asked us, "Why do you phase out just when things are going good?" It is simply because American industry is well equipped to take over from NASA. At the present time there are seven U.S. domestic companies planning to launch 16 satellites over the next two years. These are communications satellites which at the present time we feel can best be handled by private enterprise.

The use of Earth observation satellites is also expanding rapidly. NASA has worked with the Department of Commerce since the beginning of the space age to develop weather satellites, but at the present time we are flying a surprising new kind of observation spacecraft called the Earth Resources Technology Satellite, ERTS-I.

We call it surprising because we have known for years that cloud pictures from space would be valuable, but we did not realize until fairly recently what a wealth of new information could be gathered about the Earth and what man is doing to it and with it from an ERTS-type satellite flying at an altitude of 570 miles.

Thousands of scientists and public officials and industry representatives, not only in this country but around the world, are busy today scanning the images that ERTS produces. Hundreds of valuable

uses for this type of information have already been identified and more are being discovered all the time.

If I had to pick out one spacecraft, one space age development, which NASA is producing which would help save the world, I would pick ERTS and the operational satellites that will follow from it, which I believe will go a long ways towards helping man to save his home—this planet Earth.

I want to say something, too, about the Skylab Program because that is our main manned space program that is underway at the present time and we expect the second Skylab crew to return to Earth a week from tomorrow. Everything is on schedule, their health is better than the first crew even though they have been up there already 51 days, and the scientific and applications experiments aboard the Skylab have already exceeded our expectations, even the expectations we had before the Skylab was damaged at launch. Scientists and technologists throughout the country and the world are just now beginning to analyze the data.

The third Skylab crew is scheduled to be launched on November 11, and with some luck we ought to be able to take solar-type observations—ultraviolet, X-ray, and gamma ray observations—of the comet Kohoutek. Now most of you haven't heard much about Kohoutek, but you will by December because this comet will be the brightest thing in the night sky outside of the Moon. We hope the Skylab astronauts will take some very good scientific readings on this unusual comet.

To summarize this report on the new NASA space program for the Seventies, let me say the following.

We are making good progress in all important areas. So far as funding goes, we are lean but healthy. Some people say that we are undernourished, but not starved. We are doing more in this decade for less because we could build on the capabilities created in the Sixties. We are now at work on plans for the new programs we will need to start later in this decade. The next NASA Administrator to come to Cobo Hall will give you the results of this effort, which will, in time, become the new NASA program of the Eighties.

We have developed an enormous bank of new technology which is gradually being put to use in the general economy as well as into the next generation of space missions.

This new technology has moved into almost every industry and is being used in every segment of our society. This includes, of course, the automotive industry.

Now, these are not meant to be solutions, but only examples of ways that we do interleave with the automotive industry. For example, a NASA-developed computer program called NASTRAN is being used for designing critical parts of light trucks and cars. It predicts the performance of critical load structures such as steering linkages. The company using NASTRAN reports a 60 percent improvement in predicting the behavior of components under stress and a time saving of two-thirds in achieving calculations. It plans to use NASTRAN in an increasingly wide range of functions.

Another example. Some years ago the astronauts had trouble with their space helmet visors fogging up and as a result we developed an anti-fogging compound for the specialized conditions of space flight. It could also be used on car windshields and motorcycle helmet visors.

An ultrasensitive, fast-scanning infrared optical device developed by NASA is now seeing daily industrial use for testing the safety of automobile and aircraft tires.

Just recently I signed off on a patent for a new composite material which can be self-lubricating at very high temperatures and it is to be marketed soon under a licensing agreement with NASA. The composite, fluorides impregnated into porous nickel, cobalt, or iron alloys, show excellent wear-resistant qualities under test. A typical application might be in rotary engines of the Wankel type which have a high temperature lubrication requirement. And so

on. The list is long, but these are examples of the kinds of things that we call spin-offs in the space program.

I think one other example probably is worth calling your attention to. It's a spin-off, in a sense, but it's part of our effort to make NASA technology available to industry as a whole.

NASA is taking a hard look at the whole range of opportunities suggested by the use of hydrogen as a fuel. There was, for example, an article in Fortune Magazine last November which gives you some idea of what these possibilities are.

But I will mention one example only. There is a fair amount of interest at the present time in an experimental hydrogen injection program for automobile engines.

This work is going on at the Jet Propulsion Laboratory of the California Institute of Technology under a NASA contract.

The NASA/JPL Program is an exciting experimental effort to bring old and new technology to bear on one of the major problems of modern society.

Work on the program consists of two phases. Phase I began last April and will be completed in December.

The idea is simply to inject hydrogen into a standard automobile engine which is operated on a lean mixture ratio, and it turns out if you do this, the automobile engine functions rather well, at least as efficiently, probably more efficiently, than the standard engine of today and, of course, with no pollution if operated on the lean side.

I do not want to say this is a cure-all, but it does work. We have an engine that is working now at the Jet Propulsion Lab. We expect to have a car running on hydrogen injection this November.

And right now, this week and next week, we have representatives from all of the major automobile industries out there looking at the program.

Of course, we do not plan to carry hydrogen aboard automobiles, except in a demonstration test. The trick is to develop a hydrogen generator which works off gasoline.

We have active work on a hydrogen generator. We are not the ones to produce it cheaply and easily, with low weight, but nevertheless we are working closely with some representatives of the automobile industry to see whether this can be an economical way of getting low-pollution, high-efficiency automobile engines.

We first became interested in hydrogen injection through our work on airplane engines. We do this routinely, in experimental airplane engines, since we have a pollution problem there, as well.

We expect some day, maybe, airplanes will be run on hydrogen fuel—liquid hydrogen probably, in this case. We began the work on hydrogen injection for automobile engines primarily because of the encouragement we received from the Environmental Protction Agency. We work very closely with EPA on programs of this kind.

We have made a special effort at NASA to meet informally with groups of corporation executives from non-aerospace industries all around the country.

The purpose of these meetings is to brief industry people at the top executive level about advanced technology that ought to be of use.

And beyond that, we want to listen to industry leaders and get their ideas on how NASA can help. I'm convinced that our technology transfer messages are getting through at the engineering level to almost everyone in industry.

But these messages also need to be flowing to the Board Rooms as well. I plan to participate in the program personally to the extent that my schedule permits.

I had a very valuable exchange with business executives about two weeks ago down at Houston, at the dedication of the Lyndon B. Johnson Space Center. And I plan to be in Los Angeles for a similar discussion in early October, and I'm planning to schedule others throughout the country.

I would like to suggest that you might go or send some of your brightest engineers to visit the NASA Research Centers. The Lewis Research Center in Cleveland, for example, is having open-house Wednesday, Thursday, and Friday of this week.

Beyond that, it is always open-house at NASA when knowledgeable people from industry want to talk about advanced technology transfer.

Come and see us. If you don't, we'll come and see you anyway.

Thank you very much.

(Applause)

QUESTION: "DOES THE NASA PROGRAM SHOW PROMISE OF A NEW SOURCE OF ENERGY—A PRACTICAL SOURCE FOR HEATING HOMES OR DRIVING MACHINERY?"

DR. FLETCHER: No, our NASA program does not show promise of a new source of energy. Hydrogen, itself, is not a source of energy. It's only a way of transmitting energy from one form to another, which—in some cases—may be more desirable.

If we produce hydrogen, it will be produced from electrical energy by electrolysis or from coal.

You can produce hydrogen about as cheaply as synthetic gas from coal.

So, it's not really a new source of energy. It's a new form of energy.

QUESTION: "THE SKYLAB ASTRONAUTS ARE WORKING IN A ZERO GRAVITY ENVIRONMENT. IS THERE A NEED FOR DEVELOPING AN ARTIFICIAL GRAVITY ENVIRONMENT FOR SPACE TRAVEL?"

DR. FLETCHER: There are problems with the zero gravity environment. And the astronauts are learning to cope with it. We find that most of the problems, however, are health problems.

And judging by what we have done with the second group of Skylab astronauts, they seem to be much more healthy at the present time, at the end of almost eight weeks, than the previous astronauts were at the end of four weeks.

Time will tell. When we get them back on the ground they may be a little shaky in terms of walking, because they have not used their walking muscles. But aside from that, we find no difficulty at all in working at zero G and we do not plan to have artificial gravity aboard future missions.

QUESTION: "WE UNDERSTAND THE FIRST SKYLAB CREW TOOK SOME DRAMATIC PHOTOS OF THE SUN. HAVE WE LEARNED ANYTHING NEW FROM THESE PHOTOGRAPHS?"

DR. FLETCHER: The answer is unequivocally yes. It would take a long time to describe to you the new things that are coming out of these observations—it's not just photographs, but we look at the Sun with every instrument imaginable.

And the whole idea we have of the Sun now is a completely different one than we had before Skylab.

Unfortunately, the data are not all put together, so the new concept of the Sun really is not firm yet. All we can say is that the Sun is a very dynamic body.

It's a little frightening, somehow, because we depend for almost everything we do on the energy from the Sun.

And we had thought if there is anything steady and stationary it was the Sun. Unfortunately, that does not seem to be the case. It is a very mobile, dynamic, boiling, bubbling, star. Hopefully, on the average, the heat that comes to our atmosphere will be relatively constant so that we do not either have another ice age or that we don't have a burning up of our population.

So far, we've done pretty well by the Sun. It's a little scary perhaps to know too much about it, but we are beginning to focus in on what actually makes the Sun work and what are the variations in it.

QUESTION: "THE EARTH RESOURCES TECHNOLOGY SATELLITE PHOTOGRAPHS WHICH WE HAVE SEEN HAVE BEEN SPECTACULAR. SKYLAB GIVES YOU ANOTHER OPPORTUNITY TO CONDUCT EARTH RESOURCE SURVEYS. CAN YOU COMMENT ON THE ERTS PROGRAM, INCLUDING RESULTS FROM SKYLAB?"

DR. FLETCHER: Well, yes. As I said, the ERTS program itself is probably the most important thing in the long run to come out of the space program. Because it does, on a routine basis, allow us to observe every place on the globe precisely in different color bands, particularly the infrared, about every 18 days.

And so we can observe changes in what is happening to our globe, the slow changes caused by development programs but also the rapid changes, such as forest fires, diseases of forests, diseases of crops, pollution, oil spills, and so on.

And, in the long run, that's going to be the way we keep track of what is happening on our planet.

QUESTION: "IS THE JOINT SPACE VENTURE WITH RUSSIA ON SCHEDULE? ARE THERE ANY PROBLEMS BEING ENCOUNTERED?"

DR. FLETCHER: The answer to the first question is yes, the program is on schedule. Of course, it is still in the design phase on each other's side, not in a testing phase, so it is a little early to say.

We have a delegation going over to the Soviet Union in October. I have asked Deputy Administrator George Low to go with them—to be sure there are no loose ends in the program.

So far it looks like there are none, even the public relations program seems to be working out.

We were afraid that they would have to keep their part very secretive, where ours is open, but that does not seem to be the case. I think we're going to have a good public relations program. By that, I mean communications with the public, on both sides.

QUESTION: "WHAT IS AHEAD IN NASA FOR GENERAL AVIATION?"

DR. FLETCHER: Well, that's quite a broad subject, too. But we are just in the past year setting up a program office for dealing with general aviation.

The kind of things that we are working on are advanced low pollution aircraft engines, not the hydrogen engines, but a simpler design, and we are working also on low cost turbine engines.

We think the turbines and, finally, the jets, need to be reduced in cost in order for the general public to make use of them.

The airport problem is a very big one and we are working with the Department of Transportation—it's a joint program—to help find new ways of dealing with general aviation so that it does not impact unduly on military and commercial uses.

QUESTION: "WE UNDERSTAND THE THIRD SKYLAB CREW WILL GO UP ON NOVEMBER 9. WHAT IS THEIR TARGET FOR DAYS IN SPACE?"

DR. FLETCHER: The target for the next Skylab mission is 56 days, the same as for the present mission, but we cannot be precise about that, because we don't try to control the precise location of the Skylab in orbit.

And as it goes around, it deviates slightly from our calculations, due to anomalies in the Earth's gravitational field.

And so, when we say 56 days, we mean approximately 56 days. But we like to have the astronauts come down at a very precise location, approximately 300 miles off of San Diego.

What started out to be 56 days on the present mission is going to be 59 days, three days longer than first planned. All I can say is that the duration for the next Skylab flight is designed to be 56 days. It may be a little short, or it may be a little long.

There is another factor that might influence that and that is if the Comet Kohoutek turns out to be very interesting, and we are getting good data, we might just prolong that mission.

So the answer is approximately 56 days.

(Applause)

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DR. JAMES C. FLETCHER

ADMINISTRATOR

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

The Economic Club of Detroit

September 17, 1973

A LOOK AT THE NEW NASA PROGRAM

On October 1 the National Aeronautics and Space Administration will observe its 15th anniversary. And I am happy to say this anniversary finds us hard at work on new programs and new concepts that will keep us busy in this decade and set the course for this nation in space throughout the remainder of this century.

For 15 years, under four Presidents, NASA has borne the new responsibility of moving America forward into the space age, and the traditional responsibility of maintaining American leadership in the closely related field of aeronautical research.

In these 15 years, all four Administrators of NASA have had the honor and the opportunity of speaking in this important forum offered by the Economic Club of Detroit. You have also heard Wernher von Braun back in 1958 before NASA opened for business. The Apollo 15 and Apollo 17 astronauts have also been here.

I interpret these repeated invitations as indicating, not only your desire to participate personally in one of the great adventures of our time, but also your recognition that the space program has become an important force in shaping the economic future of the United States.

In preparing for this talk, it has been interesting for me to look at what the other Administrators have talked about when they came here and to see what was uppermost on their minds at the time.

Dr. Glennan spoke at some length on why we needed a space program -- which was a brand new idea then -- and on what gave a sense of urgency to the effort. In the spirit of the times, he stressed the military and political importance of competing effectively with the Soviet Union in space.

Mr. Webb shared with you his understanding of the magnitude of the technological assignment to send men to the Moon and back by the end of the decade. It is interesting to note that when Mr. Webb spoke in April 1962, the method for getting to the Moon and back had not yet been decided upon. Mr. Webb pointed out that at the time the choice seemed to be between assembling the payloads launched by two large Saturn rockets in Earth orbit or building a huge new rocket called the Nova. Actually, the decision to use one Saturn 5 and the lunar rendezvous method was made later in 1962.

I am glad this country did not have to build a Nova. The decision to choose the lunar rendezvous method was one of the critical decisions in this country's history, and one of NASA's finest achievements. We have recently been through a similar series of decisions to define the Space Shuttle, and I hope they will be as successful as the Apollo decisions.

Dr. Thomas Paine, when he was here in 1970, was most concerned with what this country should be doing in space after Apollo. He had begun the hard process of choosing the most important new missions from among the many exciting and promising possibilities which the new capabilities built in the 1960's had opened up.

There is an optimistic theme that runs through each of these talks -- and I hope you will perceive it in mine, too.

This theme is that the space program, by its very existence, is expanding our physical and intellectual horizons. Pictures from space have helped to emphasize the smallness and the fragileness of our home planet. It is important to get this truth that our resources on this planet are limited, and must be more wisely used. But the space program, in 15 years, has brought home a still more important truth: the human imagination is not limited, and can produce the new advanced technology that modern society must have in the decades ahead.

So two things are foremost in my mind today.

First, I want to bring you up to date on the new NASA programs for the Seventies. Despite the limitations on our budget, they are good programs and we are proud of them.

Second, I want to describe the great reservoir of new technology that NASA has created over the past 15 years, and how we are working with other government agencies and with industry to tap this reservoir and make more and more space age technology available to the American economy -- not just to the aerospace sector but to everyone. And that includes the automotive sector of the economy centered in Detroit.

In this connection I also want to express my concern about this country's current slowdown in creating new technology through investment in research and development. R&D, to be effective, requires a sustained investment, not only in the space program, but in all major sectors of our national economy.

When Dr. Paine was here in 1970, the new space program for this decade was still being worked out. Now we have it carefully defined and approved by the President and a strong bipartisan majority of the Congress.

There has been a natural tendency to call this the "post-Apollo" program. I want to get away from that tag line. Our plans for this decade call for new levels of [illegible] competence, new levels of performance, and new levels of technology quite different from those achieved in Apollo and other projects of the Sixties.

The space programs of this country will never be completely "new" from one decade to the next. Our advance into space has to be a continuum. But what we are doing in this decade, compared with the last, is quite different in a number of ways.

-- In our planetary programs we are going to new regions of the solar system ... far out to the giant planet Jupiter and in the opposite direction to the small planet Mercury and close to the Sun itself. And we will make our first attempt to land instruments and cameras on the planet Mars. In other words, unmanned voyages to the planets should be much more exciting and much more productive in this decade than in the Sixties.

-- We have left the Moon and will probably not return in this decade. Instead, we are building our first space base closer to home, in Near Earth Orbit. By space base, as used here, I do not mean space station or the kind of base we will some day have on the Moon or Mars. I mean the productive systems of applications satellites, the scientific observatories, the Space Shuttle to serve them, and the supporting ground stations and data distribution centers. This is indeed becoming a well established and enduring base of space operations, in many different orbits, designed to serve the peaceful needs of our country and of all mankind.

-- In place of Apollo as our lead program to create new capabilities to operate in space, we have the Space Shuttle. We have identified the Shuttle as the one essential step we must take in this decade to assure our future in space.

-- We are coming to realize more and more that the most important space programs of NASA deal not only with Outer Space, but with the environment of Earth and the quality of life on our home planet. Even our exploration of the other planets leads to a better understanding of Earth's environment and how to protect it.

-- We will have new scientific observatories in Earth orbit, but we will stress applications satellites and the practical uses of space and space technology.

-- In this decade we are emphasizing methodical preparation for intensified use of Near Earth Space in the Eighties and the Nineties. This is obvious in our work on the Space Shuttle. It is less obvious, but just as important, that we are working to improve the satellites that will be launched and serviced by the Shuttle.

-- Most of our applications satellites in the Sixties were experimental. Now we are working to mature the technology for such satellites, and are aiming at the establishment of operational systems. These will be owned primarily by other agencies of the U. S. Government, by international agencies and by private enterprises. We have a good example of this evolutionary process in the way communications satellites have moved swiftly from experimental to operational, and from government sponsorship to commercial ownership.

-- In this decade, there is less emphasis on international competition as the spur to our space effort, and growing emphasis on international cooperation in space.

-- In this decade we are much better prepared, and therefore much more interested, in finding ways that space technology can be used throughout the economy. We are a problem-solving agency, and our methods and our experience are applicable to problems in other fields. We do not think it very realistic to sit back and wait for technology spin-off to occur. We believe it much more productive to identify the problem areas where NASA know-how is applicable, and then to act positively to make the necessary technology transfer. But we can do this only at the invitation of the other government agencies -- state, local and federal -- who have responsibility for the problem involved, or in cooperative arrangements with private industry.

-- Finally, there is a difference in budgets. In the peak years of the Apollo program NASA expenditures ran between $5 and $6 billion per year. Our activities for this decade are now at a budget level of $3 to $4 billion per year, including about $300 million for aeronautical research. We believe that within the confines of this limited budget we can still maintain a strong, balanced, and productive space program. We have accepted the challenge of doing more for less. And we will be well prepared to move more rapidly in any important area of space activity if the need to do so arises.

Those are the general characteristics of the New NASA Program for the Seventies. Now let us look at what we are actually doing, at the missions themselves:

Although we are concentrating on activities in Earth orbit in this decade, we will not neglect the planets. We have two Pioneer satellites now on the way to the giant planet Jupiter. Pioneer 10 will pass by Jupiter in early December of this year. If Pioneer performs as expected, and sends back data over half a billion miles, the results should be very exciting. I hope you will have the opportunity to follow them closely. Pioneer 11, which is now passing through the dangerous asteroid belt, will pass Jupiter in December of 1974.

In 1977 we will launch two larger and more complex Mariner-type spacecraft to fly by both Jupiter and Saturn.

In early November of this year we will launch a Mariner spacecraft on an unprecedented mission in toward the Sun, flying first by Venus, using the gravity of Venus to gain extra speed, and then flying quite close to the planet Mercury -- as close as 600 miles if all goes well. If launched on schedule, this Mariner will pass Mercury during April of next year. It will be the first spacecraft to use the gravity of one planet to speed on to another, and the first to get a close-up look at Mercury. The view of Mercury seen through Earth-based telescopes reveals almost no details.

Surface details of the planet Mars are now well known, thanks to the thousands of photographs sent back in 1972 by Mariner 9. Mariner 9 was the first spacecraft from Earth to go into orbit around another planet (not counting the Moon as a planet). When it arrived at Mars late in 1971 a gigantic dust storm was raging, and the planet was obscured. But because Mariner 9 was in orbit, it was able to wait out the dust storm and get excellent pictures of the Mars surface. It was also able to make unexpected and very valuable observations on the dynamics of the dust storm while it waited.

Mars turned out to be much more interesting than we had thought. The Mariner pictures showed volcanic mountains higher than any on Earth, and a canyon several thousand miles long and deeper than the Grand Canyon on Earth. The presence of water on Mars was also indicated in some of the pictures.

The Russians succeeded in soft landing a TV camera on Mars in 1971, but it functioned for less than a minute and returned no useful pictures because of the dust storm.

The Russians have four spacecraft now on the way to Mars. Two of them are expected to send down landers when they reach Mars in 1974.

We have launched no spacecraft to Mars this year, but will be well prepared for the next opportunity, or "launch window" as it is called, which will be in 1975. We will launch two large Viking spacecraft to Mars in 1975, and each of them will send down a landing capsule weighing more than a ton, including fuel to provide braking power. Each of these Mars landers is expected to send back TV pictures and search for signs of life. Our landings will take place in mid-summer of 1976, and it is possible that one of them will occur on the Fourth of July, when we celebrate the 200th anniversary of American independence.

We are also participating in a promising scientific program with the Germans to send two Helios spacecraft close to the Sun in 1974 and 1976. When I say close, I mean within about 28 million miles, which is about three-tenths of the distance between Sun and Earth. This is much closer than any scientific spacecraft has ever come to the blazing center of the solar system.

These are all very interesting and potentially rewarding expeditions. We have no approved planetary missions after 1977, but these will be developed as we begin to get back results from current missions to Jupiter and Mercury and the Viking landings on Mars.

I would like to come back to the Pioneer 10 flight to Jupiter for a few moments because this is a current mission of great potential interest, and because it is a transportation story of the first magnitude.

Pioneer 10 was launched on March 3, 1972. It left the Earth at 32,000 miles per hour, faster than any man-made object had ever flown before. If the Apollo astronauts could have travelled that fast, they could have reached the Moon in 11 hours instead of 3 1/2 days. Pioneer 10 has been underway for 18 1/2 months and has covered nearly half a billion miles.

If Pioneer 10 is not destroyed by the radiation from Jupiter, or trapped by its gravity field, it will continue outward from the Sun and about 14 years from now it will cross the orbit of Pluto and leave the solar system forever to wander through the star systems of the Milky Way galaxy. We have a plaque on board which is Pioneer 10's calling card if it is ever intercepted by intelligent beings. The plaque displays drawings of two human figures, a sky map showing Pioneer's point of origin, and other coded messages which could probably be readily understood by any beings advanced enough to capture our spacecraft.

Pioneer 10 is also a communications story of the first magnitude. It is not a big spacecraft to begin with. It weighed only 568 pounds when launched, so the allowance for communications equipment, power sources, and antennas was quite limited.

Pioneer 10 carries radio isotope thermoelectric generators as its primary source of electrical power. Pioneer travels too far from the Sun to use solar panels to produce power. So necessity becomes a mother again, and produces the radio isotope thermoelectric generator! Pioneer's radio signals will start from the vicinity of Jupiter with a strength of eight watts. Not kilowatts. Eight watts. Travelling at the speed of light they will still take 45 minutes to reach the tracking stations of NASA's Deep Space Network.

By the time Pioneer's signals reach Earth, they will be decreased in strength to only a tiny fraction of a watt. But we are well prepared for that. Our very large parabolic antennas, 210 feet in diameter, can pick up signals from Pioneer as weak as one quintillionth of a watt. If you could collect that amount of energy for 19 million years, it would light a small Christmas tree bulb for only a fraction of a second. Still, NASA's Deep Space Network stations in Australia and Spain and at Goldstone, California, expect to pick up these weak signals and convert them into useful data, including some color images of Jupiter.

I find these figures impressive; but I cite them for you to make another point. They illustrate how way out assignments like exploring the planets force technological progress and help fill the nation's reservoir of new technology.

If tiny Pioneer 10 is able to send back useful new information about Jupiter or any of its 12 satellites, it will be one of the great scientific and engineering achievements of this century. Pioneer 10 is only the beginning of a long quest for knowledge that will eventually lead men to land on one of the moons of Jupiter sometime during the 21st century.

Meanwhile, back in Earth orbit, we have important work to do in this decade. Even as we prepare to explore the famous rings of Saturn, we are establishing useful spacecraft in rings about the Earth.

We have moved forward rapidly with three classes of satellites in Earth orbit. They are communications satellites; Earth observation satellites; and scientific satellites which look out into the universe.

We are at the moment flying an important fourth class -- the Skylab multi-purpose manned space station.

The success of U. S. communications satellites has been based on three major technological advances: the ability to get useful payloads into geosynchronous orbit 22,300 miles above the equator; the ability to stabilize these spacecraft and provide them with operating power; and finally, the development of light-weight, long-life communications equipment.

Satellites in synchronous orbit appear to be standing still, because they are travelling at the same speed the Earth is turning. They can see and be seen from more than a third of the Earth. Thus three of them, passing messages back and forth, can maintain constant radio and television communications between any two points on Earth. In short, geosynchronous orbit is a rather fabulous place. It is the "in" place of the Space Age. Quite seriously, it is becoming apparent that geosynchronous orbit is the most important place we have discovered yet in our advance into space. It is a place where much useful work can be done for the human race -- by those who can get there.

Communications satellites are only the beginning. Within a few months, we will put the first operational weather satellites in geosynchronous orbit, where they can observe and report on the development of violent thunderstorms and tornadoes as well as keep a constant watch on weather patterns over the whole United States day and night. Some day we may have solar power stations in geosynchronous orbit, transmitting the electrical power they have generated to Earth by microwave. That is feasible only if the solar power station is standing still in space, relative to the Earth. In other words, it is feasible only in geosynchronous orbit. That will be true of many other kinds of useful work to be performed out there in the rings of Earth.

The first successful communications satellite in synchronous orbit was Syncom 2. It was launched 10 years ago, and weighed only 80 pounds. The communications satellites in use today weigh more than 1,000 pounds in orbit. Private enterprise had a lot to do with the success of the Syncom project. The Hughes Aircraft Corporation took the initiative in urging the use of synchronous orbit for communications satellites and made a substantial investment of its own funds to prove that Syncom was feasible before NASA took over responsibility for it.

Less than two years after Syncom 2 proved out the concept, the first commercial satellite was launched by NASA for Comsat, the Communications Satellite Corporation.

Comsat has five satellites of advanced design working in synchronous orbit right now. Two are over the Atlantic, two are over the Pacific, and one is over the Indian Ocean. They serve nearly 100 ground stations in 83 countries which are members of the International Telecommunications Satellite Consortium, or INTELSAT. Satellites already handle more international telephone traffic than undersea cables.

Each of Comsat's five satellites can handle up to 9,000 telephone conversations at one time or 12 television channels. The availability of all these channels has led to a rapid increase in the volume of international communications, and rates have been cut. For example, the cost of a three-minute call from New York to London has gone down from $9 to $5.40 in the past three years.

Canada is the first country to use a satellite in synchronous orbit for domestic communications. This is the Anik satellite which NASA launched for Canada in April of this year. Canada was first, but at this time NASA has requests from seven U. S. domestic satellite companies, or groups of companies, to launch 16 satellites over the next two years, thus producing an enormous increase in our capacity for transcontinental TV and telephonic communications, including data transmissions.

(The Russians also use communications satellites to relay television programs to the eastern part of their vast country, but they do not use synchronous orbit. They use a highly elliptical orbit that seems to serve their purposes for the time being, at least.)

Next year NASA will launch an advanced satellite (called ATS-F) for experimental broadcasts that can be picked up by inexpensive community-type antennas in remote areas. It will be used first in Alaska, the Rocky Mountain states, and Appalachia. Then it will be moved eastward for experimental broadcasts to community antennas in several thousand villages in India. The educational programs for these experimental broadcasts will be supplied by the Indian government.

NASA is now phasing out of the business of developing new technology for commercial satellites. We feel that this is a job that private enterprise can and should handle.

It is obvious that communications satellites are going to play a rapidly expanding role in the economic and cultural life of the whole world.

The use of Earth observation satellites is also expanding rapidly. NASA has worked with the Department of Commerce since the beginning of the Space Age to develop and improve weather satellites. Remarkable progress has been made. The new weather satellites we plan to put in geosynchronous orbit are but one example.

Now we are also flying a surprising new kind of observation spacecraft called the Earth Resources Technology Satellite, or ERTS-1. I call it surprising because we had known for years that cloud pictures from space would be valuable, but we did not realize until fairly recently what a wealth of new information could be gathered about the Earth and what man is doing to it from a ERTS-type satellite flying at an altitude of 570 miles.

Thousands of scientists and public officials and industry representatives around the world are busy today scanning the images that ERTS produces. Hundreds of valuable uses for this typw of information have already been identified, and more are being discovered all the time.

There is not time to even begin to tell what ERTS can do or how it does it. But I would like to make several general points:

ERTS is the product of many technological advances. We have a spacecraft in precise orbit that covers almost the entire globe repetitively every 18 days. Sensors have been developed that reveal much more than ordinary color photographs would show. And what the sensors see is designed for computer processing so that relevant information -- and only relevant information -- can be delivered routinely and rapidly to the people who interpret and use it.

This wealth of new information, reduced to readily usable form at nominal cost, comes at a time when it is urgently needed. It is needed for better management of natural resources. It is needed to monitor air and water pollution on a global scale. It is needed for better urban and regional planning. It is needed to check on the health of our forests and of grain crops around the world, to estimate the moisture content of soils, and to predict the water supplies available in the snow cover of remote mountains. In short, it is needed to flash the red warning lights on the control panels of spaceship Earth; and the green lights of progress, too.

If I had to pick one spacecraft, one space age development, to help save the world, I would pick ERTS and the operational satellites which I believe will be evolved from it later in this decade.

Of course, we don't have to pick just one, we have many. And that is why I am optimistic about the future of the world. We do have the intelligence and the vision, not just in NASA but in our modern society, to strengthen its good points and overcome its ills.

Skylab, our first manned space station, is also demonstrating what trained observers with even more sophisticated and specialized instruments can do as weather watchers, Earth observers, and astronomers.

Since we have both ERTS-1 and Skylab in orbit at the same time, we are getting an excellent demonstration of what automated spacecraft can do in space compared with what men can do. The answer so far is what we had expected. For the foreseeable future, we will need both manned and automated spacecraft.

The automated spacecraft will make the routine, repetitive observations. Men will be needed to help develop and test new instruments for the automated satellites; to operate instruments which cannot be automated at reasonable cost; and to take advantage of unusual opportunities that only the intelligence of man can recognize.

Everything that has happened on Skylab, from the health of the astronauts to their performance as astronomers and repairmen, has demonstrated the value of developing large multi-purpose manned space stations for the future.

As you are probably aware our Skylab mission is progressing very well after overcoming a series of problems. In fact the crew now up there -- Alan Bean, Owen Garriott and Jack Lousma -- are performing even better than we had expected. They are doing more work than originally planned and indeed have been able to perform some experiments which were scheduled for the next Skylab mission.

The crew's health and spirits after 52 days in orbit are excellent. Their body weight has been relatively constant since early in the mission and their cardiovascular systems appear to be responding similarly to those of the first Skylab crew in its 28-day mission.

We have been fortunate in observing some interesting phenomena on the Sun such as flares, prominences, loops and ejections of material. One event ejected material having several times the weight of Earth and containing as much energy as the Earth's population could use in 500 years at current rates.

The Sun, of course, is the source of all energy here on Earth and the data we are collecting about it in the Skylab mission may give us clues as to how to solve or alleviate our long-term energy needs.

Also the crew has been able to carry out more Earth resources work than originally expected. Just last week, for instance, television pictures from Skylab as it passed over the drought area in Africa hinted that observations from space might indicate where underground water could be found.

The current Skylab mission will end on September 25 after a record 59 days in space. The next Skylab mission is scheduled to be launched November 11 and its 56-day duration will give us the opportunity to study and make instrument observations of the Comet Kohoutek which will approach and pass around the Sun in December and January. The appearance of this Comet, discovered earlier this year, is a real bonus to the scientific world, and the fact that Skylab will be on station and able to use its unique instrumentation for observation truly is a fortunate coincidence.

We are building the Space Shuttle so that it can be used to launch all of our unmanned satellites, except perhaps the smallest ones; and so it can also be equipped with a Space Laboratory module which transforms it into a small special purpose manned space station for missions of seven days, or even up to 30 days, duration.

I have two favorable reports to make on the Shuttle. We have made good progress in getting it defined and under contract. It is now being built.

And we have reached a mutually advantageous agreement with a number of West European countries whereby they will develop the Space Laboratory module for use with the Shuttle. This is estimated to cost $300 million. This agreement is a major step forward in international space cooperation. So is the agreement President Nixon and Chairman Kosygin signed for the rendezvous and docking of an Apollo spacecraft and a Russian Soyuz spacecraft in orbit in 1975.

To summarize this report on the New NASA Space Program for the Seventies, let me say:

-- We are making good progress in all important areas.

-- So far as funding goes, we are lean but healthy; we are undernourished, but not starved.

-- We are doing more in this decade, for less, because we could build on the capabilities created in the Sixties.

-- We are now at work on plans for the new programs we will need to start later in this decade. The next NASA Administrator to come to Cobo Hall will give you the results of this effort, which will in time become the New NASA Program of the Eighties.

-- And we have developed an enormous bank of new technology which is gradually being put to use in the general economy, as well as into the next generation of space missions. This new technology has moved into almost every industry and is being used in every segment of our society. This includes the automotive industry. Here are some examples:

-- A NASA-developed computer program is being used for designing critical parts for light trucks and cars. Called NASTRAN (for NASA Structural Analysis computer program), it predicts the performance of critical load structures such as steering linkages. The company using NASTRAN reports a 60 percent improvement in predicting the behavior of components under stress and a time-saving of two-thirds in achieving calculations. It plans to use NASTRAN in an increasingly wide range of functions.

-- Some years ago our astronauts had trouble with their space helmet visors fogging up. As a result, we developed an anti-fogging compound for the specialized conditions of space flight. It can also be used on car windshields and motor cycle helmet visors.

-- An ultrasensitive, fast-scanning infrared optical device developed by NASA is now seeing daily industrial use for testing the safety of automobile and aircraft tires. The device is the first that permits non-destructive testing of tires.

-- A new composite material which is self-lubricating at high temperatures is to be marketed soon under a licensing agreement with NASA. The composites -- fluorides impregnated into porous nickel, cobalt or iron alloys -- show excellent wear-resistant qualities under test. A typical application might be in rotary engines of the Wankel type which have a high temperature lubrication requirement.

-- A vehicle emission analyzer that can be used by assembly line personnel features low cost, high reliability, and easy maintenance. It was first developed by Chrysler for hazardous gas detection during work on the Saturn rocket. The analyzer also has broad application in automotive dealerships and government regulating agencies. It is about one-third the size of comparable emission analyzers thanks to the advanced infrared energy beam technology it uses.

-- Another space launch vehicle program spinoff is the wiring harness tester. It automatically tests 100 percent of the electrical components installed at each station of the trim line. A complete test for a car is done in 60 seconds.

-- A novel speed indicator was developed by one of our engineers at the Marshall Space Flight Center in Huntsville, Alabama. Using his space program knowledge, the engineer -- who works weekends with the Alabama Department of Public Safety -- developed the "elapsed time speed computer". It consists of a low-cost electronic computer and two roadside markers on the route being observed. A timing switch is turned on automatically when a vehicle passes the first marker and turned off when it reaches the second. The elapsed time, measured accurately by an internal computer clock, is automatically compared with the distance between the markers, giving the vehicle's average speed. The entire system, which would cost no more than $200, compares in size with a thick textbook and weighs only three pounds. The Huntsville Police Department is using the new device, and other law enforcement agencies are observing its operation.

The items I have just mentioned are what we sometimes call "spinoff". It is an important form of technology transfer, and NASA makes an intensive effort to facilitate it.

As I see it, "spinoff" will be only a part, perhaps only a small part, of the technology transfer from NASA activities which should take place over the next several decades.

Most major transfers will probably result from more formal efforts; they will probably come from the definition of a problem by a user agency of government or industry, and a formal agreement with NASA to try to solve that problem, or at least certain aspects of it. And we are indeed getting such assignments.

For example, in 1971 the Advanced Automotive Power Systems Office of the Environmental Protection Agnecy requested NASA's technical assistance. The agency's program looks toward development of practical automobile gas turbines as an alternative to the reciprocating internal combustion engines now in use.

An Automotive Power Systems Office has been set up at NASA's Lewis Research Center in Cleveland to coordinate the Center's activity in support of EPA objectives. Its work includes analytical studies, experimental tests, design of low emission turbine combustors, low-cost manufacturing techniques, high temperature systems, simplified engine and fuel controls, and systems engineering. Recently, EPA has asked that the Lewis Center accept responsibility for a broader gas turbine technology program, and an interagency agreement to this effect has been made. It involves a significant expansion of NASA's current work in this field.

For this program, EPA has furnished NASA with a sixth-generation Chrysler gas turbine dating from the late 1960's as a baseline engine to "map" its performance and to upgrade it. This work will begin this week. Our specific goals are lower emissions, better performance, reduced cost, and longer engine life. We plan to demonstrate by October 1975 a gas turbine automobile engine which meets federal 1976 emission standards and which has minimum impact on performance, fuel consumption and cost.

A second and quite different example of how we are working with other agencies and industry to use space technology on Earth is a program called MIUS, which stands for Modular Integrated Utility System.

The MIUS concept is to eventually develop a more efficient and fully integrated utility system to supply a housing development or a shopping center or small community. For example, a housing complex would be supplied with electricity from a generator on the site. What would ordinarily be waste heat would be used on the site for heating or air conditioning. Solid wastes will be burned in an efficient manner to provide additional energy. Waste water and sewage will be re-cycled on the site. Emphasis would be on engineering this system to perform these services in a way that conserves natural resources, lessens air and water pollution, and reduces energy consumption.

This is not just a theory. NASA has a contract with the Hamilton Standard Division of United Aircraft Corporation to set up a laboratory module of MIUS at the Johnson Space Center in Houston. This test version will be installed in a 3,000 square foot area of one of the large buildings at the Space Center, beginning in December. It will be large enough to serve the utility needs of about 60 people, which is a substantial number for a laboratory-type test of the concept and subsystems. I hope it will attract many visitors from the construction and utility sectors of the economy, and from urban planning disciplines.

I should emphasize that MIUS is a program of the U. S. Department of Housing and Urban Development, and NASA is assisting HUD. Other agencies cooperating with HUD in the program are the Atomic Energy Commission, the Environmental Protection Agency, and the National Bureau of Standards. The National Academy of Engineering, under contract to HUD, has established the Integrated Utility Systems Board to provide an independent assessment of the program. So you can see this is a very serious program.

NASA is also taking a hard look at the whole range of opportunities suggested by the use of hydrogen as a fuel. You have probably read articles recently entitled "The Coming Hydrogen Economy", or something like that. There was such an article in Fortune magazine last November. I also recommend the August issue of the magazine Astronautics & Aeronautics as a good example of how my colleagues in aerospace approach the so-called energy crisis. Although widespread use of hydrogen as a fuel will not be achieved in the near future, NASA believes the "hydrogen economy" concept deserves serious consideration.

As you know, liquid hydrogen and liquid oxygen were used to power the upper stages of the giant hydrogen rocket that sent the Apollo spacecraft to the Moon. So NASA has played a leading role in developing the most advanced methods for producing, handling, and using liquid hydrogen.

We are especially interested at the present time in the possibilities of using liquid hydrogen as a fuel for the jet engines of large advanced aircraft. Hydrogen is an excellent high performance fuel which produces practically no pollution. We know it can be burned successfully in jet aircraft engines at high altitude because we have already tried it -- back in the late Fifties when we wanted to make such a test before committing to the use of hydrogen in the Saturn rockets. Much work remains to be done, of course, to demonstrate the economic feasibility and develop the special equipment needed.

NASA is also very much interested in another way that hydrogen <u>might</u> be used to help clear up pollution and save fuel. I emphasize the word <u>might</u>.

I am referring to the experimental Hydrogen Injection Program (HIP) which NASA is funding and which is being carried out at the Jet Propulsion Laboratory of the California Institute of Technology under NASA contract.

This NASA/JPL program is an exciting experimental effort to bring old and new technology -- very advanced new technology -- to bear on one of the major problems of modern society. Work on the program is proceeding in two phases. Phase one began in April and will be completed in December.

Two principal steps are being taken in phase one to demonstrate the potential benefits of the concept by injecting relatively small amounts of hydrogen gas into the gasoline and air mixture to be burned in a standard automobile engine. The first step, which is already underway, uses bottled hydrogen and an engine on a laboratory test stand. The second step, to begin next month, will test the concept in the actual operation of an automobile, with the bottled hydrogen being carried in the trunk.

The preliminary laboratory results from the first step show a significant reduction in pollution without an increase in fuel consumption. So far as I know, this is the only current effort to clean up the emissions from an internal combustion engine which does not involve a penalty in the form of higher fuel consumption. In fact, our preliminary figures indicate that hydrogen injection may even produce a fuel saving. This would come, apparently, not only from the direct effect of the hydrogen on the combustion process but also from the better atomization of the fuel mixture.

I want to make clear that the bottled hydrogen is being used only in these feasibility tests. If and when the system is perfected, the hydrogen will be produced from small amounts of gasoline and water in a generator near the engine. Thus phase one of the program also calls for the concurrent development of a laboratory model of such a generator. Work on this generator is progressing, and tests of it will be run in the next several months.

If the feasibility tests using bottled gas are successfully completed, phase two of the program will be initiated late this year. Phase two will attempt solution of the many engineering problems involved in integrating the hydrogen injection system, the hydrogen generator, the necessary fuel controls, etc., into a smooth running automobile. Phase two will probably continue for a year or two.

NASA is primarily interested in this program to reduce pollution and improve the efficiency of the gasoline internal combustion engines used in small aircraft. This is a matter of some urgency, because these engines will have to meet anti-pollution standards set by the Environmental Protection Agency by the end of 1979. We are using automobile engines in this program because they are less expensive than aircraft engines and more convenient to test. But the principle is the same for any type of engine using gasoline or other hydrocarbon fuels.

I must stress again that this is an experimental program, and still in the early stages. The chances that you will some day have a hydrogen injection system under the hood of your car are probably less than 50-50. But if the concept does prove out and the engineering problems are solved in the NASA/JPL program or elsewhere, you can foresee the impact on American industry and the American environment as well as I can.

Teams of engineers from General Motors, Ford, Chrysler, and American Motors have been invited to JPL and Cal Tech this week and next. The General Motors group will be there today and tomorrow; the Ford group will be there Wednesday and Thursday. The Chrysler people will come in on September 24 and 25 and American Motors on September 26 and 27.

The idea of hydrogen injection in internal combustion engines is not new. For example, as far back as 1935 the Langley Aeronautical Memorial Laboratory did work on hydrogen injection into the diesel engines of airships. Because the hydrogen in these airships had to be bled off from time to time, the Langley people were looking for a good use for it and they chose to try hydrogen injection. If the airship had not faded out of the national picture at about that time, we might have seen the introduction of hydrogen injection engines decades ago. Work on the concept was also performed in Europe in the 1920's and 1930's.

But of course it is the present emphasis on combatting pollution -- and conserving fuel -- that makes our work on hydrogen so relevant today.

I have cited several examples of how NASA's research centers, working with other government agencies and industry, can make a conscious effort to bring about technology transfer from advanced aerospace into the general economy. The investment is relatively small. The returns may be correspondingly modest, or they may be tremendous. These are investment risks this country should take.

Technology transfer from NASA research is "catching". But you can easily immunize yourself by looking the other way. Please don't. This is a form of "contagion" that will be good for American business -- and labor. For the American balance of payments. For the American quality of life. We urge you to look our way.

We are making an especial effort at NASA to meet informally with groups of corporation executives from non-aerospace industries around the country. The purpose of these meetings is to brief the industry people at the top executive level about advanced technology that ought to be of use. And beyond that, we want to listen to industry leaders and get their ideas on how NASA can help. I am convinced that our technology transfer messages are getting through at the engineering level to readers of the trade press. But they may not be coming through to the board rooms.

I want to participate in this effort personally to the extent my schedule permits. For example, I had a valuable exchange of views with executives of the oil industry when I went to Houston last month for the dedication of the Lyndon B. Johnson Space Center. I am going to Los Angeles for a similar technology transfer meeting in early October. I hope we can schedule others. I do want to emphasize that the meetings I have in mind are with people who are not connected with aerospace. The aerospace people already have the word, and much of the technology.

I also suggest that you might go, or send some of your brightest engineers, to visit the NASA research centers or the NASA regional dissemination centers for technology transfer. The Lewis Research Center, for example, is having an inspection or Open House on Wednesday, Thursday, and Friday of this week.

Beyond that, it is always Open House at NASA when knowledgeable people from general industry want to talk about advanced technology transfer. Come see us, or we will come see you.